



Advanced Technology Flight Simulation

Executive Summary



REDIFFUSION
Simulation

World leaders through technology, experience and commitment

For more than three decades Rediffusion Simulation has led the world in flight simulation, a highly competitive and technologically challenging business.

In that time the company has built over 400 simulators and trainers representing 85 different aircraft types for 110 airline and military customers throughout the world.

Indeed, with its technological superiority and aggressive business policy, Rediffusion Simulation has regularly captured more than 40% of the world's commercial flight simulator market.

In particular, since building Europe's first fully electronic simulator in 1950, for the Boeing Stratocruiser, it has effectively led the world in developing flight simulators and trainers for airlines and training authorities.

From the first commercial jets to Concorde, from today's most advanced aircraft to the world's first full flight simulator for a civil helicopter, the firm has continued to break new ground in pilot training technology.

So much so, that under international regulatory certification, airlines are now able to transfer all routine pilot conversion and recurrent training from the aircraft to Rediffusion flight simulators, a fact that has reduced operating costs, eliminated unnecessary training flights and substantially improved overall flight safety. Such achievement stems not only from a commitment to advancing the technology of training, but also from the commercial stability of parent BET, the international services company.

BET provides specialist support

services to industrial, consumer and public sector markets, has a total sales turnover approaching £1.5 billion, with 70,000 employees and some 250 operating companies.

BET's business is organised into five core activities – industrial services, transport, construction, electronics and leisure and publishing.

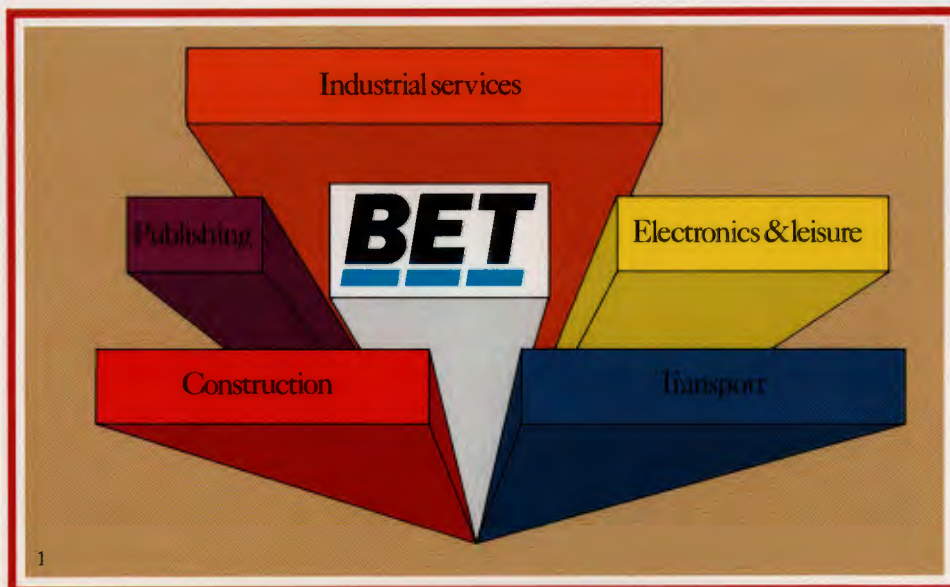
Of these Rediffusion Simulation is the largest subsidiary in electronics and leisure, itself generating a sales turnover around £100 million and employing 2,000 people.

As well as its mainstream business, the company has diversified into new growth industries such as leisure, interactive training systems and industrial process simulation to exploit profitably its existing skills and techniques.

From an administrative and production base in Crawley, Sussex, Rediffusion Simulation also maintains factories at Aylesbury, Brighton and Strood in the UK and Rediffusion Simulation Incorporated, a wholly owned subsidiary in Arlington, Texas.

And there are close commercial and technical links with specialist companies – Evans & Sutherland Computer Corporation in computer imagery, Projectron Incorporated in display technology, and British Caledonian in flight training.

1. BET is the international services company.
- 2-5. Rediffusion has built flight simulators for all the latest aircraft types including Alitalia's MD Super-80, Varig's B747, Pacific Southwest Airlines' BAe 146 and Helikopter Service's Super Puma.



A totally realistic training environment

In Rediffusion's latest generation equipment every aspect of design, manufacture and operation is innovative.

The result is that these simulators more than satisfy the requirements of both operators and regulatory authorities worldwide in the transfer of training away from the aircraft. In particular they meet the UK Civil Aviation Authority's CAP453 level four and the US Federal Aviation Administration's Phase II and III zero flight time specifications.

So, the design criterion of Rediffusion's advanced technology simulators creates a totally realistic training environment in terms of both the physical and performance characteristics of the aircraft.

In physically reproducing the flight deck, maximum use is made of actual instruments and equipment – an advantage if spares or aircraft updates are required – although simulated components, too, are available. And, for optimum utilization, dual flight deck configurations will allow, for example, interchangeable Boeing 737-300 and -200 series flight deck configurations.

Realism in the flight deck is matched by 32 bit computing resolution capable of maximising the benefit derived from today's comprehensive data packages. While high speed 30 Hz iteration rates and advanced software techniques allow performance to be correlated throughout the simulator's motion, control, visual and sound systems.

These systems, too, are designed from the outset to faithfully recreate every aspect of the actual aircraft, including computer generated image visual

simulation of the outside world, advanced display technology such as WIDE and digitally controlled feel and motion cue generation.

And in service validation of the simulator's performance, relative to aircraft data, which is crucial to the operator in reducing acceptance timescales and in periodic regulatory checks, is met by the computerised test management system which verifies both hardware and software performance.

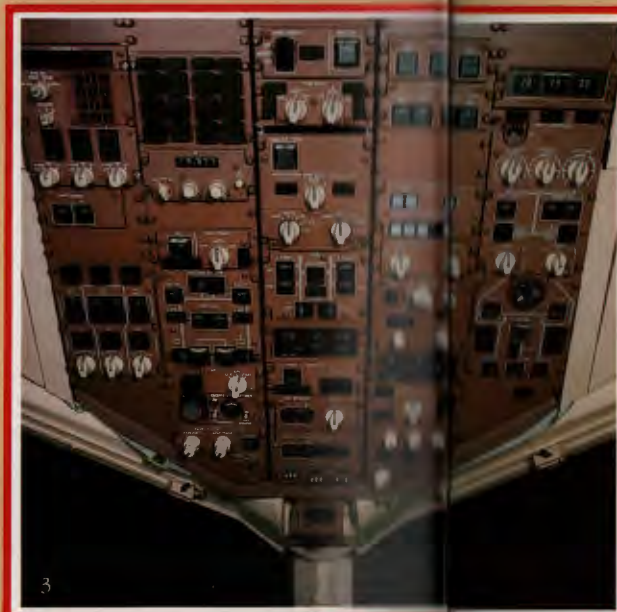
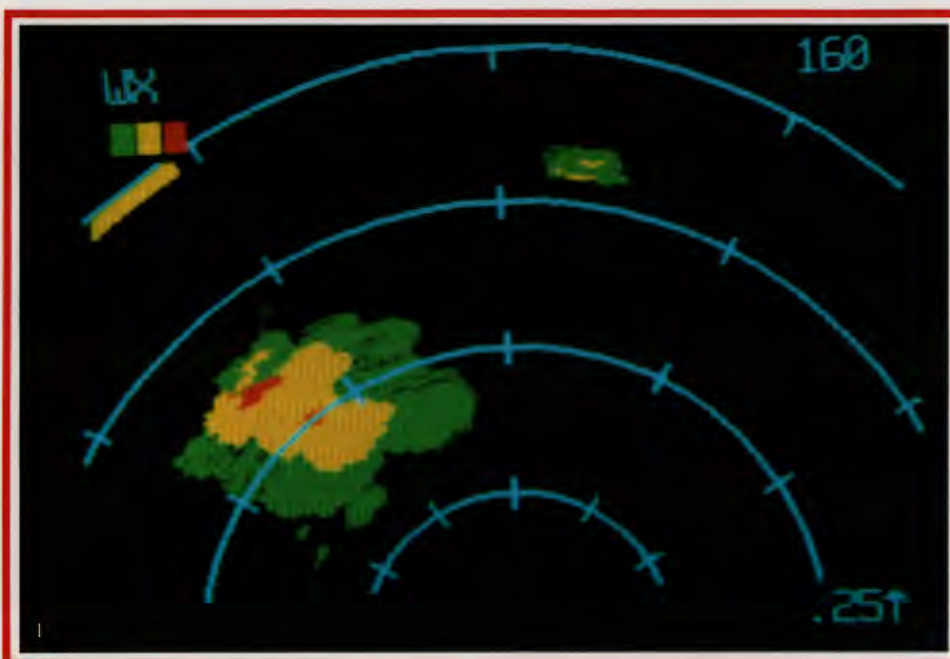
Furthermore, the total training environment is further enhanced by the new Touch Activated Simulator Control instructor facility and an ergonomically designed aftcab. Together these create the impression of an aircraft interior while allowing the instructor to become more fully integrated in his training role.

As a working environment, the design philosophy of Rediffusion's latest simulators places great emphasis on physical accessibility of modules to facilitate maintenance with on-line fault diagnostics and comprehensive microprocessor controlled test equipment allowing circuit testing to component level.

Today's simulators are, therefore, the ultimate training tool, a tool which routinely achieves 99% operating availability in a 20 hour day.

1. Rediffusion offers fully integrated weather radar
2. Novoview SP1 night approach displayed on WIDE.

3-5. A totally realistic training environment is crucial in terms both of the physical and performance characteristics of the aircraft.



Computer generated visual and sound simulation systems

In the past five years Rediffusion has captured no less than 70% of the civil visual simulation market.

Today's Novoview range meets the full spectrum of training requirements from night/dusk to full daylight, all with the option of texture. And it includes CGI systems to meet all current and proposed international regulatory criteria.

Indeed, Rediffusion's day/dusk/night Novoview SP3 and the textured SP3/T were the first systems to meet the FAA's Phase III requirements. The range also includes night/dusk SP1 and its field retrofittable texture option, SP1/T, to meet Phase II and equivalent requirements, and the new SP-X family of systems.

SP-X, like all Novoview products, was jointly developed with Evans and Sutherland Computer Corporation and provides the optimum in realism and flexibility. Its unique modular configuration means SP-X is upward expandable from night/dusk to full daylight, each with the options of extra high resolution (HR) and three-dimensional texture (T). While advanced features such as pixel fog, fade level of detail and high scene quality and stability provide a level of realism compatible with route clearance training.

And Rediffusion's image generation systems are compatible with all relevant state-of-the-art display technology.

The solutions available include monitor based systems. But, while these meet all current flight training regulations,

they do not permit cross cockpit viewing and so remain fundamentally removed from the real world.

Wide-angle Infinity Display Equipment (WIDE), however, does present CGI scenes to the entire flight deck without optical limitation and provides an uninterrupted field-of-view extending 150° horizontally by 40° vertically.

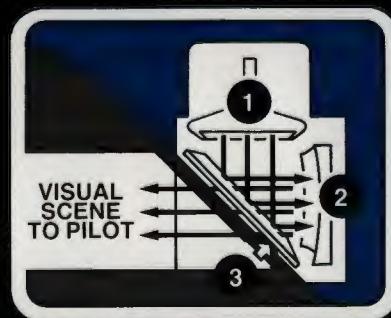
Launched in 1981 and with over 50 systems sold, WIDE has revolutionised the realism of simulator training. In WIDE, the image, formed on a back projection screen by calligraphic projectors, is viewed via a large diameter collimating mirror.

The range has been extended to include SupraWIDE which provides new levels of picture quality and resolution, and WIDE II which creates a continuous 200° by 40° scene allowing abeam and over-the-shoulder views.

WIDE set-up has also been reduced to minutes with the introduction of SPHERE so costly, time consuming line of sight gauges do not need to be used.

Visual standards are matched by proven levels of sound fidelity, which have been achieved by sophisticated sound measurement and analysis techniques, together with multi-channel presentation around the flightdeck.

1. WIDE and monitor based display concepts.
2. SupraWIDE's high picture quality.
3. SP-X luminous surfaces.
4. SP-X pixel calculated fog.
5. SP1/T two-dimensional texture for height and speed cues.



1. CRT display
2. Collimating mirror
3. Beam splitter

Fully flexible touch activated simulator control facility

Touch Activated Simulator Control is the world's first flight simulator instructor facility to combine touch screen technology with micro-processor control.

Essentially, it means instructors spend less time operating the simulator and more time training.

This is because the system incorporates a number of advanced features which allow the instructor to easily retrieve information from, and issue instructions to, the simulator.

In particular, interaction between the touch screen and the micro control eliminates the time-consuming need for a manually activated search, through pages of data, to establish essential status information relating to the simulated aircraft, or its operating environment.

This information is now available at a touch of the screen and can be presented in a unique overlay panel windowed onto any alphanumeric or graphics page.

It also has a much more powerful colour graphics capability than previous systems. So it can provide a more usable presentation of information and a level of textural and pictorial detail to give the instructor clearly understandable, informative feedback of crew actions.

As a micro-processor based system, Touch Activated Simulator Control is fully compatible with both mainframe and distributed host computer systems. And, indeed, its self contained processing power means that exercise planning time can be cut and exercises set up off-board while the simulator is being operated.

Great care has gone into designing this system so that it is easy to use, both operationally by the instructor and off-line by the maintenance team. An example is the choice of FORTRAN, virtually the industry standard for simulation software, as the core of the display page language, ensuring a powerful user in-house

modification capability.

Touch Activated Simulator Control also takes account of the fully automated and repeatable facilities needed for LOFT procedures. And, as a complete software package, it can incorporate a comprehensive library of data items, malfunctions, environmental and system controls, which can be tailored to meet the operator's precise training regime.

Physically, the console and aft cab have been ergonomically designed to ease operation and to integrate the instructor more closely with the flight crew under training. For example, because the system itself is modular, the console has been designed to be used with one, two or even three monitors.

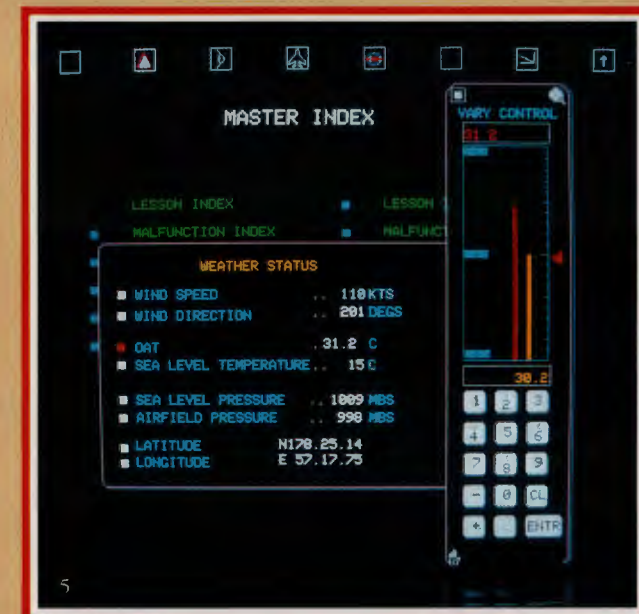
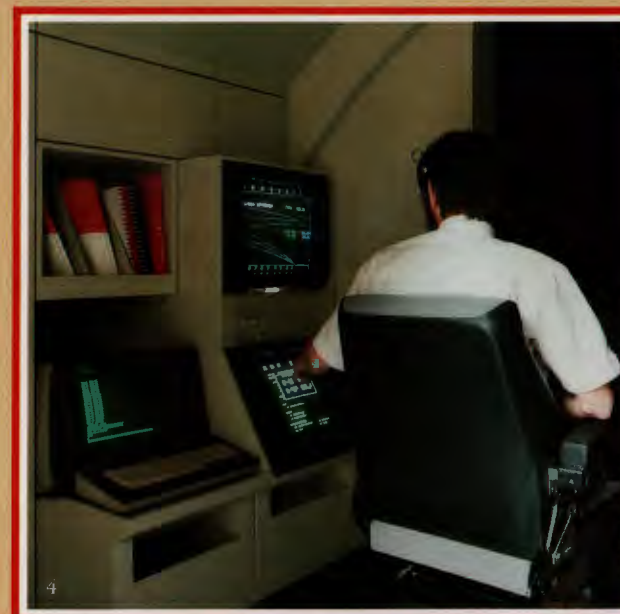
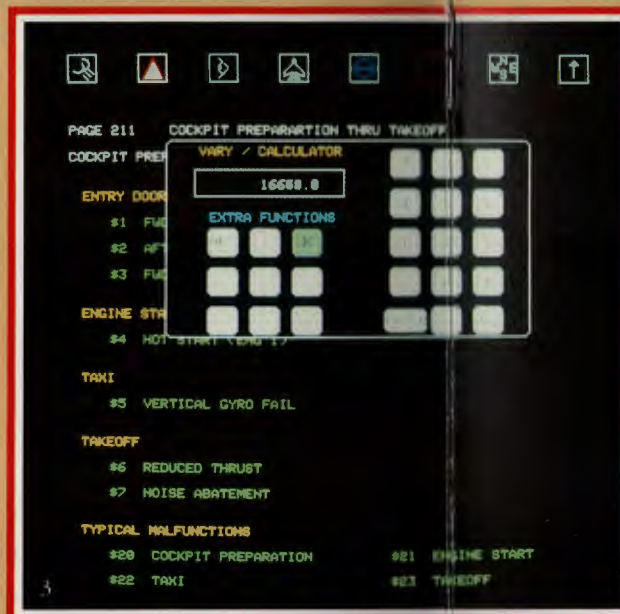
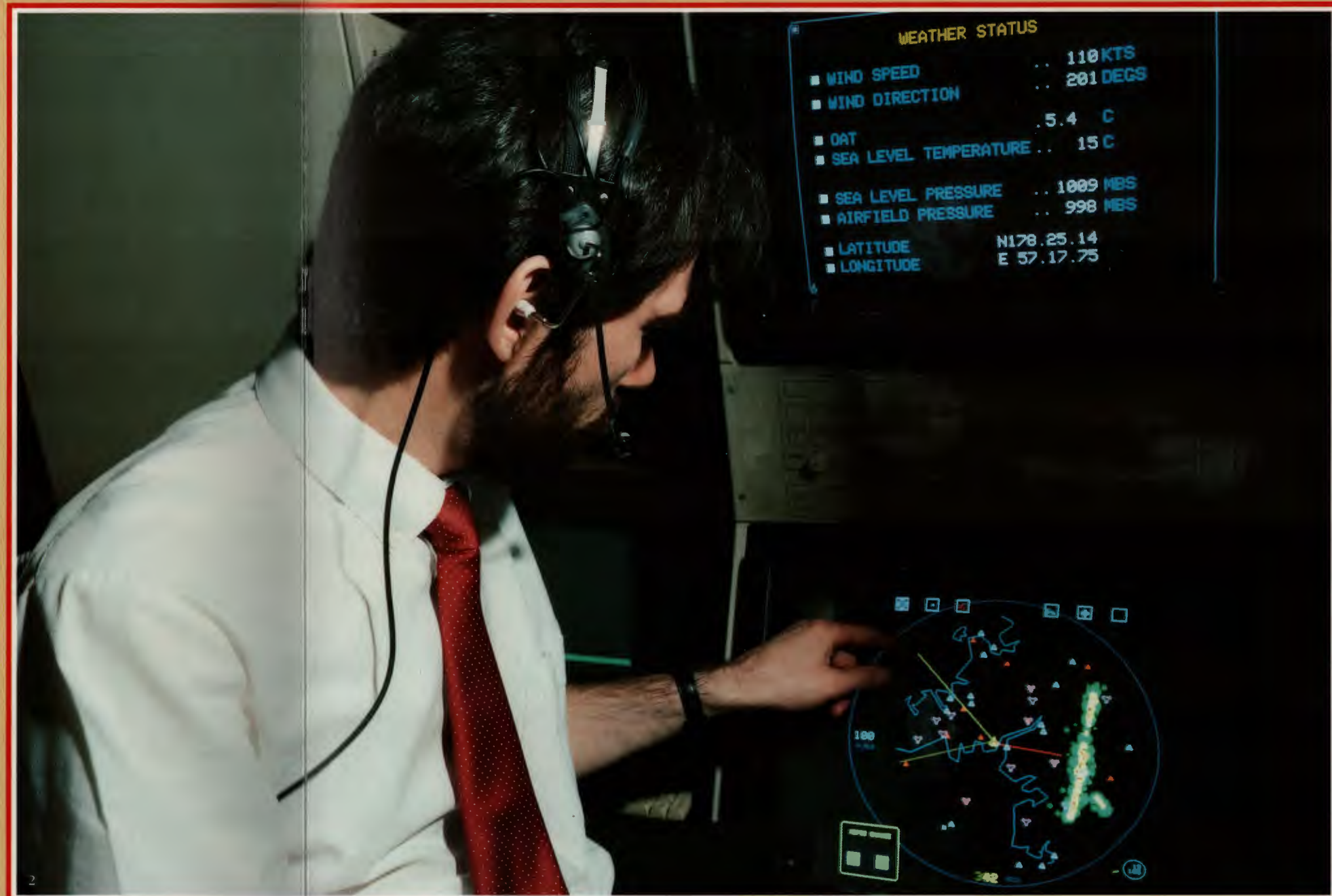
In particular, the direct action switch panel has been completely redesigned using state-of-the-art switch technology and layout, so that it is aesthetically compatible with aircraft environment and the entire complex is concentrated within the instructor's immediate field-of-view.

Its modular construction also both allows flexibility of configuration and drastically reduces the spares holding. The use of LED based status indicators and twin bulb switch and plate lighting also adds inherent reliability and cuts the need for daily maintenance.

Furthermore, display page contents and dynamic graphics can be hard copied on the host computer matrix printer or onto an optional on-board unit for immediate flight deck debriefing.

And a portable control unit is also available so that the instructor can exercise full control from crew positions.

1 & 4. The aft cab has been ergonomically designed for fully integrated training.
2. Touch controlled moving weather display.
3 & 5. Unique overlay panels.



State-of-the-art computing techniques

Rediffusion has consistently led the field in the application of computer technology to flight simulation. It introduced Gould computers in 1976 making them today's industry standard with well over a million hours training on Gould equipped Rediffusion simulators.

As a result the company has in-depth experience covering micro-processor techniques, multi-processor and large single processor mainframes, as well as highly cost-effective distributed processor applications.

Flexibility of approach has long been a goal so that computing power can be efficiently matched to training task.

With the increasing size of modern aircraft data packages, the need for spare computing capacity to incorporate expansion and development and increasing data processing requirements, Rediffusion believes that distributed computing based on reflective memory can provide the most efficient solution.

The company was, therefore, the first manufacturer to adopt Gould's SCI-Cone/32 concept which was designed from the outset around the real-time simulation task.

SCI-Cone is based on the use of processors, such as the proven Gould 32/27 or 32/67, organised into computing nodes and linked by a unique high speed reflective memory system as well as a low speed 'housekeeping' bus.

A dedicated data processing node is used to ensure that there is always the computing capacity to deal with simulator software maintenance without interrupting training by separating the simulation tasks from the data processing tasks.

But, above all, such a technique provides the ultimate in modular flexibility. An operator can have his simulator's computing requirement tailored precisely to his aircraft type

knowing that, once in service, as more data becomes available or training needs extend, computing power may be expanded simply and cost-effectively by adding more processors.

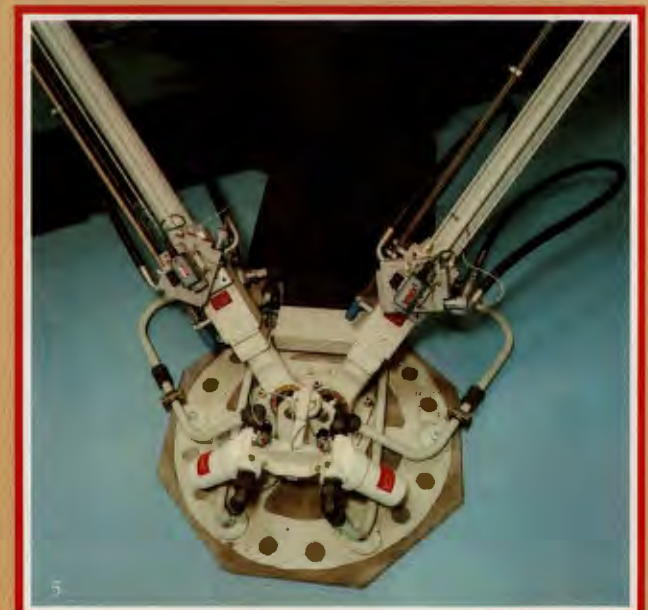
Whatever computing solution is selected, Rediffusion will provide the latest LSI/CMOS component interfaces with digital multiplexed data transmission techniques. These allow a high-speed data throughput with correspondingly high accuracy and reliability. By grouping interface channels, according to type, on function boards, standardized proven designs can be used across the entire range of Rediffusion simulators – a significant logistics advantage.

The benefits of distributed computing are particularly evident in integrated cue generation where Rediffusion is implementing dedicated SCI/Clone processors to handle the simulator's totally digital motion and control feel systems. So, in dispensing with analogue elements, the company has improved not only the accuracy but also the reliability and repeatability of this simulation.

The latest generation six degrees of freedom motion system has been designed to take full benefit from 32 bit computing accuracy and 500 Hz iteration rates, and produces smooth, low velocity motion, as well as the essential onset accelerations.

The motion system uses ultra-low friction hydrostatic technology to produce all the six axes of aircraft movement in flight while in the control feel system this same technology is employed to ensure a smooth and realistic response to pilot inputs.

1. Digital control feel.
2. Six degrees-of-freedom motion systems.
3. Gould's SCI-Cone/32 concept.
4. Comprehensive micro-processor based testing.
5. Ultra-low friction hydrostatic actuators.



A full range of supplementary training equipment

Technological superiority aside, Rediffusion is also unique in the marketplace in its ability to offer complete training packages.

This means the customer can enjoy commonality of equipment in his entire training regime. Because, as well as highly sophisticated full flight simulators Rediffusion provides a total range of equipment for every level of training including computer based training.

With limited fleets, a full flight simulator may not be justifiable. So, Rediffusion offers a small aircraft simulator concept to meet the needs of regional, commuter and corporate operators.

This simulator has a unique modular construction which is compatible with both the need for low-cost build and the smaller size of the aircraft cockpit. Its motion system has been optimised to reduce installation time and site size, yet it can still meet FAA Phase II.

Increasing utilisation of full flight simulators can lead to throughput limitations especially as the growing complexity of aircraft avionics places extra demands on integrated training systems.

Although every trainer is custom-built, the generic term has three divisions.

The cockpit procedures or systems trainers are designed primarily to allow familiarisation with flightdeck layout and operation. These, therefore, have a full simulation of an aircraft's systems so that crews can learn operational procedures, in depth, under both normal and emergency conditions.

A CPT can be used with a full simulator so that, to maximise the efficiency of training, time in the simulator is not used in simple familiarisation.

Part task simulators are designed to fully represent a specific aspect of training associated with a particular aircraft. For

example, a Flight Management System simulator would comprise a flightdeck with a fully operational FMS, its associated systems and representative flight characteristics.

Flight trainers can provide a low-cost alternative to a simulator for basic flight, navigation and airport procedures. These are usually associated with smaller or less sophisticated aircraft and may have basic flying capability based either on a specific aircraft type or generic cockpit.

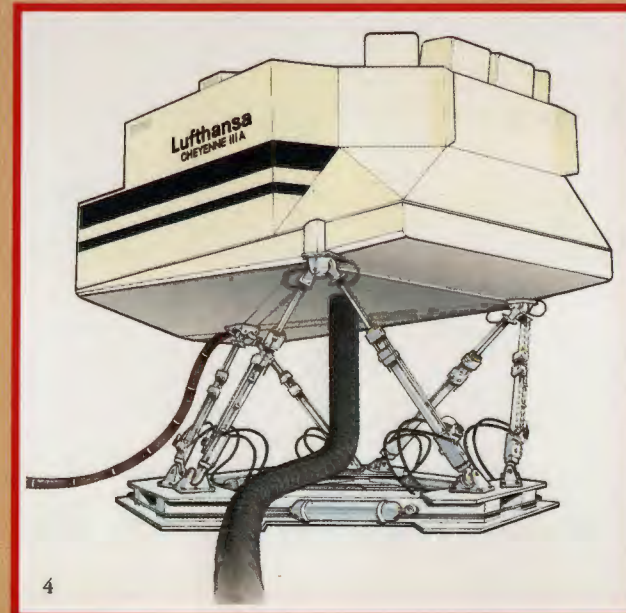
And, in the ground support training area, maintenance trainers simulate aircraft systems, avionics and mechanisms to enable ground personnel to identify the effects of aircraft malfunction both on the flight deck and on maintenance related line replaceable items.

Rediffusion can also supply computer based Interactive Training Systems for self-paced, individual or classroom tuition. The company's training experts will analyse the requirement with the operator's in-house specialists, design and develop the courseware and necessary hardware, implement and support the package.

The range of equipment can include full integrated micro computer based terminals and screens, audio, video, textbooks and slides.

These ITS systems can be networked so that student terminals can operate anywhere in an organisation with central monitoring of performance. They can also be coupled with Rediffusion developed real-time simulation software to configure systems familiarisation trainers for procedures and principles training.

1. FMS simulator.
2. Full flight simulator and cockpit systems simulator.
3. Interactive Training Systems.
4. Small Aircraft Concept.
5. Systems familiarisation training.



Comprehensive maintenance and product support

The entire Rediffusion simulator complex has been designed with the accent on reliability and maintainability. Standardization in major components has increased simulator commonality and enhanced cost-effective maintenance facilities.

Automatic diagnostics, designed for use with line replaceable units, feature in all main equipment areas, including the computer, electronics, motion, control loading and visual systems.

Specifically, the SCI-Clone computing concept has identical processors so maintenance is dramatically simplified and spares holdings can be reduced by at least 50%. One node can also be included in the system as a hot spare, instantly available to take over.

Touch Activated Simulator Control's substantial processing power means new levels of diagnostics capability have been built in to component level while the reduction in electro-mechanical switches, too, increases reliability.

In the motion system interchangeable wear-free hydrostatic actuators and greaseless PTFE/glass fibre universal joint bearings have field proven maintenance-free service lives. Component accessibility is a specific design feature, including externally mounted ultrasonic feedback units and servo valves.

These and countless other features have been carefully designed to provide a comprehensive overall maintenance profile. And customer engineering staff can, therefore, ensure that average non-scheduled down time is less than 1% of operation.

Customers can also take advantage of the Rediffusion Simulation training school

which offers detailed 'hands-on' courses on simulator systems including operating, location and interfaces with servicing, fault finding, and the maintenance practices emphasised for each system. Courses can be tailored to specific customer needs and refresher, or specialist courses on computer software programs or other complex systems are available.

Technical documentation, based on ATA 100 standards, is prepared by specialist engineers and authors. The package consists of bespoke maintenance and operating manuals, comprehensive software data and associated systems diagrams for fault finding and unit repair. A range of spares schedule with recommended maintenance tools and test equipment is provided.

The product support department provides a full range of services to support customers' operational and maintenance needs, including supply of spare parts and equipment repairs, technical assistance back up and service bulletin information. The company offers both long and short term field service engineering contracts for either total maintenance or advisory assistance.

Product support regional managers provide a direct access channel for customers' enquiries and undertake regular liaison visits to customer sites to discuss operational requirements. User conferences are held annually for customers' representatives to exchange information and operational experiences.

1. Simple touch screen alignment testing.
2. SPHERE facilitates WIDE set-up.
3. Component accessibility.
4. Wear-free hydrostatic actuators.
5. Hands-on customer training.



A **BET** ELECTRONICS COMPANY



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